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ISBN 0-7729-4168-8

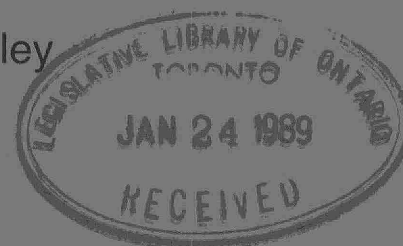
PHYTOTOXICOLOGY ASSESSMENT SURVEY
INVESTIGATION IN THE VICINITY OF
CRANE CANADA LIMITED,
STRATFORD, 1987

AUGUST 1988



Environment
Ontario

Jim Bradley
Minister



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**PHYTOTOXICOLOGY ASSESSMENT SURVEY INVESTIGATION IN THE
VICINITY OF CRANE CANADA LIMITED, STRATFORD, 1987**

Phytotoxicology Section
Air Resources Branch

Author: George N. Vasiloff

ARB No. 046 - 88 - Phyto

AUGUST 1988

Introduction

En 1976, le personnel de la région du Sud-Ouest a demandé que la Section de phytotoxicologie entreprenne une analyse de la végétation et du sol au voisinage de Crane Canada Limited, à Stratford. En raison de la nature des activités de l'usine (fabrication de baignoires, d'éviers, etc.), il soupçonnait Crane d'être une source importante d'émission de bore.

Une analyse des feuilles prélevées pendant l'étude phytotoxicologique initiale en 1977 a révélé une présence excessive de bore (plus de 200 ppm) au site 1. En 1978, les conclusions de l'étude ont indiqué que les sites 1 et 6 présentaient des concentrations excessives et que la teneur en bore au site 1 était passée de 366 ppm en 1977 à 667 ppm en 1978.

En 1977 et 1978, les échantillons de feuilles prélevés ont été également analysés pour y déceler la présence de métaux lourds. Les conclusions ont montré que les concentrations de plomb, de zinc, de cadmium, de fer et de cuivre n'étaient pas excessives et que l'usine ne produisait pas de dépôts continus.

Suite à ces premières conclusions, l'étude annuelle de la végétation a été élargie pour comprendre des sites supplémentaires; elle devait porter exclusivement sur le contrôle des émissions de bore. En 1982, des échantillons de sol ont été prélevés aux sites 1 et 12 (sites témoins) pour déterminer les

teneurs en bore. Les résultats ont nettement montré que la moyenne de 6,3 ppm trouvée dans le sol du site 1 dépassait de beaucoup la concentration de 1 ppm considérée comme potentiellement phytotoxique. Au site 12, la concentration moyenne était de 0,2 ppm.

**Phytotoxicology Assessment Survey Investigation in the Vicinity of
Crane Canada Limited, Stratford - 1987**

Phytotoxicology Section
Air Resources Branch

ARB No. 046 - 88 - Phyto

Author: George N. Vasiloff

Introduction

In 1976, the Southwestern Region requested that the Phytotoxicology Section undertake a vegetation and soil surveillance in the vicinity of Crane Canada Limited in Stratford. Because of the nature of activities at the plant, (manufacture of bath tubs, sinks, etc.) the Region suspected that Crane might be a significant source of boron emissions.

Boron analyses of the foliage collected during the initial Phytotoxicology survey in 1977 indicated the presence of excessive values (over 200 ppm) at Site 1. In 1978, survey results indicated that excessive values were present at Sites 1 and 6 and that values of boron at Site 1 increased to 667 ppm in 1978 from 366 ppm in 1977.

In both 1977 and 1978, the collected foliar samples were also analyzed for a number of heavy metals. Results showed that lead, zinc, cadmium, iron and copper concentrations were not excessive and no pattern of deposition related to the plant was evident.

As a result of these initial findings, the annual vegetation survey was expanded to include additional sites and dedicated to the monitoring of boron emissions exclusively. In 1982, soil samples were collected from Sites 1 and 12 (control) for the determination of available boron values. Results clearly showed that the 6.3 ppm average found in the soils obtained from Site 1 was significantly above the 1 ppm level considered potentially phytotoxic. At Site 12, the average level was 0.2 ppm.

1987 Surveillance Visit

On September 16, 1987 the Phytotoxicology Section conducted an annual vegetation surveillance visit at 10 previously established sites in the vicinity of Crane Canada Limited. Figure 1 shows the locations of the survey sites and demonstrates their strategic placement around the plant.

At each site, foliage facing the plant was examined for boron injury symptoms. Such injury was noted and rated according to the standard Phytotoxicology injury severity scale. Leaf samples which displayed typical boron-type symptoms were collected for retention by the Phytotoxicology herbarium.

Following the observational phase of the survey, single samples of the examined foliage facing the plant were collected for chemical analysis. All samples were returned to the Phytotoxicology laboratory in Toronto for pre-analysis processing according to a standardized 'not washed' procedure. Processed samples were submitted to the Ministry's Inorganic Trace Contaminants Laboratory for the determination of boron values.

Field Observations

The 1987 surveillance visit was advanced several weeks in order to ensure that any boron vegetation injury would not be obscured by senescence. The visible injury ratings obtained during the 1987 surveillance have been listed in Table 1 along with those from 1984 to 1986.

The silver maple foliage at survey Site 1 was the most severely injured of all vegetation species associated with the surveillance program. Coincidentally, boron values were also found to be highest in this foliage.

Rather severe injury was also observed on the ash at Site 1 and the Norway maple foliage at Sites 4 and 5.

At Site 10, both silver and Norway maple trees are examined for visual injury. In 1986 and 1987, boron-like injury symptoms were observed on the foliage of the silver maple and boron values in the analyzed samples were relatively high. Conversely, no injury has been observed on the Norway maple at Site 10 and boron values in the foliage have been quite low. At present, this anomolous situation cannot be explained.

Chemical Analysis Results

In order to provide a historical perspective of boron concentrations found in the vicinity of Crane Canada Ltd., chemical analysis results from 1977 to 1987 have been assembled in Table 2.

Values in excess of the Phytotoxicology upper limit of normal

guideline have been underlined. This guideline was formulated from a large group of samples collected from areas of Ontario (urban and rural) not subject to the influence of point source emissions. The guideline represents the mean of available analytical data plus three standard deviations of the mean. Ninety-nine percent of contaminant levels from samples obtained from areas not affected by point sources will lie below this 'upper limit of normal'. Note that the boron upper limit of normal value was revised in 1985 (175 from 200 ppm) as a result of the adoption of the above mentioned statistical basis for calculation.

Chemical analysis results of the 1987 vegetation indicate that boron values have increased at 9 of the 10 surveillance sites since 1986. At 5 sites, 1987 values escalated rather dramatically. At Site 1, the boron concentration in the ash increased from 280 ppm in 1986 to 990 ppm in 1987 - an increase of 253%! At the same site, the 1987 boron value in the silver maple increased 185% - from 200 ppm in 1986 to 570 ppm in 1987. At Sites 4, 6 and 10 the 1987 increases were 154%, 507% and 73%, respectively.

At Sites 1, 3, 4, 6, and 10 (silver maple), the 1987 boron values found in the surveillance foliage were the highest ever detected in the vicinity of the Crane plant.

Summary

The 1987 boron levels found in not-washed vegetation increased sharply from 1986 at 5 sampling locations relatively close to the Crane plant.

The number of sites with boron values above the Phytotoxicology guideline increased from 3 in 1986 to 5 in 1987.

At 5 survey sites, 1987 boron values found in the sampled vegetation were the highest ever found in the vicinity of this plant.

In spite of the dramatic increases in boron values found in some of the 1987 survey vegetation, the sites with the greatest values were, in all but one case, located less than 150 metres from the Crane plant. With the exception of the one anomalous result (Site 10: silver maple), the zone of boron influence appears to be relatively small and is restricted generally to the immediate industrial area.

Future Surveillance Initiatives

Research has shown that plant roots of vegetation growing in boron-contaminated soils take up available boron and translocate it to the leaves resulting in foliar injury. Although some of the foliar injury observed near the Crane plant may have occurred as a result of root uptake (as was shown in the limited soil sampling in 1982), the full extent of contribution from the soil source cannot be determined.

In the 1988 field season, however, a comprehensive soil surveillance will be conducted at each survey site in order determine if

phytotoxic levels of available boron are present in the soils. This may shed additional light on the anomalous Site 10 finding.

Secondly, a moss bag network will be established at each of the sites in an attempt to monitor airborne emissions of the element and assist in partitioning the air and soil borne components of the foliar results.

FIGURE: 1

Locations of Vegetation Surveillance Sites
in the Vicinity of Crane Canada Limited, Stratford

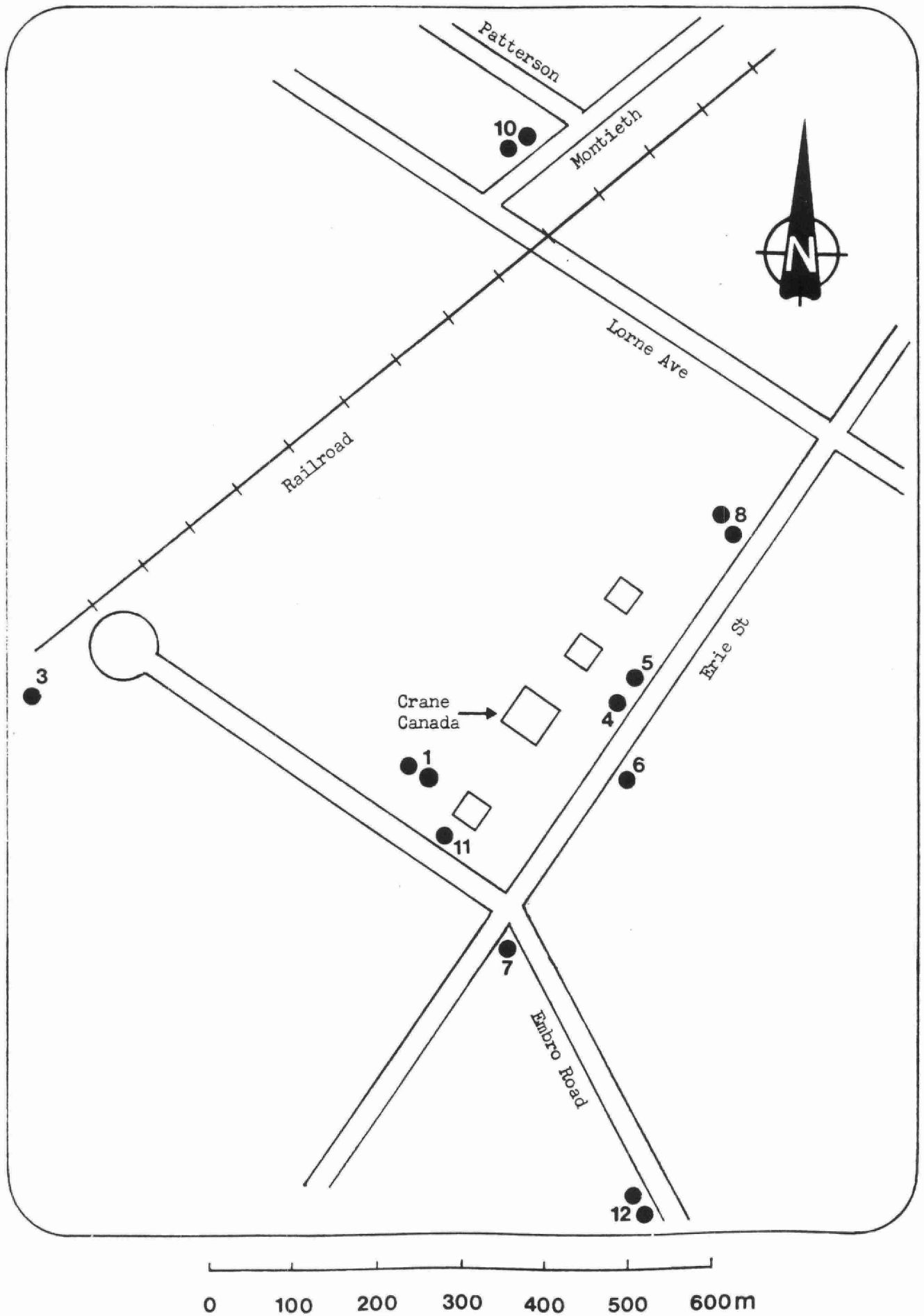


TABLE: 1

**Comparative Boron-Type Visible Foliar Injury
at 10 Sample Sites in the Vicinity of Crane Canada Limited
1984 - 1987**

Sample Location Number	Sample Species	Distance & Direction from Crane Canada	Visual Injury Rating			
			1984	1985	1986	1987
1	silver maple	150m W	4	4	NA ²	4
1	white ash ³	150m W	4	3	NA ²	3
3	silver maple	600m W	0	0	0	0
4	Norway maple	100m ENE	2 ¹	3	NA ²	3
5	Norway maple	125m NE	1	0	2	3
6	silver maple	125m SE	2 ¹	3	NA ²	2
7	silver maple	275m S	0	2	NA ²	2
8	silver maple	350m NE	0	0	0	0
8	Norway maple	350m NE	0	0	0	0
10	silver maple	700m N	0	0	2	1
10	Norway maple	700m N	0	0	0	0
11	Norway maple	175m SSW	0	1	0	1
12	silver maple	600m SE	0	0	0	0
12	green ash	600m SE	0	0	NA ²	0
<u>Phytotoxicology Injury Rating Scale (Percent of Leaf Area Affected)</u>						
0 - normal			3 - 11-35%			
1 - >0-1%			4 - >35%			
2 - 2-10%			5 - 100%			

¹ boron-type injury partially obscured by senescence.

² no injury evaluation possible due to senescence.

³ green ash sampled in 1986 and 1987

TABLE: 2

A Comparison of Boron Concentrations in Not-Washed Foliage Collected at
10 Sample Sites Near Crane Canada Limited, Stratford
from 1977 to 1987

Sample Location Number	Plant Species Sampled	Boron Concentration (ppm, dry weight)									
		1977	1978	1980	1981	1982	1983	1984	1985	1986	1987
1	silver maple	<u>366</u>	<u>667</u>	<u>395</u>	<u>563</u>	<u>700</u>	<u>674</u>	<u>583</u>	<u>457</u>	<u>280</u>	<u>990</u>
1	white ash ²	NS	NS	NS	NS	<u>375</u>	<u>267</u>	<u>350</u>	<u>357</u>	<u>200</u>	<u>570</u>
3	silver maple	NS	54	66	39	65	77	52	59	55	87
4	Norway maple	NS	NS	178	<u>200</u>	<u>390</u>	<u>311</u>	<u>250</u>	<u>283</u>	<u>180</u>	<u>457</u>
5	Norway maple	NS	NS	141	184	195	<u>249</u>	190	130	140	<u>194</u>
6	silver maple	NS	NS	290 ¹	NS	<u>390</u>	<u>467</u>	<u>560</u>	<u>433</u>	130	<u>789</u>
6	Norway maple	NS	<u>278</u> ¹	NS	NS	NS	NS	NS	NS	NS	NS
7	silver maple	NS	123	135	158	155	170	107	107	100	127
8	silver maple	113	NS	104	100	110	153	113	133	120	145
8	Norway maple	NS	NS	81	75	135	133	113	94	95	119
10	silver maple	71	59	—	118	<u>380</u>	<u>350</u>	<u>347</u>	<u>317</u>	<u>260</u>	<u>450</u>
10	Norway maple	NS	68	79	66	100	82	102	80	72	80
11	Norway maple	NS	NS	130	112	165	135	123	100	100	110
12	silver maple	NS	41	49	66	60	62	63	30	24	NS
12	green ash	NS	NS	NS	NS	55	68	54	63	50	43
Phytotoxicology upper limit of normal concentration in not-washed urban foliage		200	200	200	200	200	200	200	175	175	175

¹Unreported in the 1982-83 report.

²Green ash sampled in 1986 and 1987

NS Not sampled



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